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AUTHOR(S):

Nishimura, Shuzo

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A TEST OF THE PHYSICIAN-INDUCED DEMAND HYPOTHESIS IN JAPAN

By Shuzo NISHIMURA*

I Introduction

When an old economic theory is powerful, it survives so long enough until to be forgotten by everybody even if it has lost the reality. Therefore, economists who want to present a new theory, have to make every effort to test the validity of the old theory.

However, it is not often the case that some old theories are rejected by econometric analysis. Even if an old theory is rejected by an econometric analysis, another data or another econometric technique often justifies it.

Even worse, it is often the case that during the controversy on the plausibility of two alternative theories, the old theory gradually changes itself slightly. And researchers forget what an original theoretical model aimed to analyze.

The controversies on the physician-induced demand theory and the competitive market theory about the determination of the health care costs appear to have such a history. As Reinhardt [1978] pointed out, it is not easy to induce the validity of these two alternative hypotheses. Since the competitive market theory does not appeal intuitively, some researchers have been trying to change the formulation of the model.

At the present state, these modifications of the original model seem to stem from researchers' ideology, or at least from researchers' views of the world. The point of the controversy is whether patients/consumers can judge the quality of the health services.

Though, intuitively, it appears that it is not easy for patients/consumers to judge the quality of them, some researches show us that, at least, in the primary health care market, they have significant power on the determination of the physicians' fee. People who are on the side of the competitive approach have their own ideology, that is, patients/consumers *should have* enough knowledge to choose much competitive physicians.

As far as the ideology is concerned, I consent to this ideology. And I am sure that recent development of the research on the medical technology assessment and on the medical decision making will highly effective on making patients/consumers choose alternative kinds of health care. However, as will be shown later in section III, system of the Japanese health care is far from the situation which patients/consumers choose among alternative kinds of health care.

In this paper, I try to show two results. First, it is shown that physician induced demand hypothesis is more plausible in Japan. Though it is not easy in the United States to reject the competitive market hypothesis, in Japan, like other Western countires, it

* Professor, Faculty of Economics, Kyoto University.

seems to be quite easy to show the plausibility of physician-induced nature of the health care costs.

When we compare the situation in the Western nations and in Japan with that of the United States, it is evident that the amount of copayment by the patient relative to the total cost is significantly higher in the United States than in Western nations and Japan. If the amount of copayment is quite significant, competitive market approach may possibly be effective. Slight changes of the amount of copayment, however, will not make patient to be cost-conscious for the health care.

My second purpose in this paper is to investigate the effect of the copayment on the increase of the total health care costs. In recent years, in Japan, policy makers seem to have such an ideology that patient/consumer should be more cost-conscious about the choice of physicians. And they, by referring to competitive theories of health care costs, tried to show that the increase of the amount of the copayment could control the increase of the health care costs.

I will criticise these analyses and will show that these analyses are derived from the econometric misspecification of the model.

II The Model

The model which is tested in this paper is quite simple. I will follow the model which was shown in Reinhardt [1978] in order to clarify the difference between the physician-induced hypothesis and the competitive market hypothesis. I will summarize this model in the following.

The competitive market hypothesis of physician behavior would have the physician maximize an objective function

$$U=U(Y, W),\ U_Y>0\ U_W<0; \qquad [1]$$

subject to the demand constraint

$$W=R\cdot f(P),\ f_P<0 \qquad [2]$$

and the definition of net income

$$Y=P\cdot W-C(W), \qquad [3]$$

where Y=the physician's net income per period
W=an index of the physician's rate of "output" per period (however defined)
P=the average fee per unit of the output index
R=the population-physician ratio in the physician's market area
$C(W)$=A cost function representing the *minimum* practice cost (excluding the value of the physician's own time) at alternative output rates (W).

By adding several assumptions which satisfy the second order conditions, we can derive following propositions. According to the competitive market hypothesis, the average fee

level (P) decreases as the physician-population ratio ($1/R$) increases, that is, dP/dR must be positive.[1] Per capita utilization ($f(P)$) is predicted to increase as physician-population ratio ($1/R$) increases, according to the competitive approach. Another signs such as dW/dR and dY/dR cannot be determined a priori.

Intuitively, these propositions can be explained as follows: when physician-population ratio increases, competitive pressure makes physicians to decrease the fee level, and it makes physicians to accept more patient visits.

It seems that there is one difficulty in applying this hypothesis to the case of Japan. In Japan, most of providers are reimbursed by the compulsory insurance system which fixes the fee schedule. Fees are prefixed for each itemized diagnosis and treatment.[2]

However, if we understand the original meaning of the physician-induced hypothesis, it may be suitable to take cost per case as a proxy variable of the fee. This interpretation is taken also in the case of West Germany in Kraft and Schulenburg [1986]. In this case, $f(P)$ can be understood as the number of case per population.

The model described above can only test the qualitative nature of the alternative two hypotheses. Since I want also to know the quantitative nature of the relationship between the demand and the price, estimations are done more straightforwardly, that is, following lniear regressions are estimated.

$$\log p=a_0+a_1 \log d+a_2 \log n+a_3 \log b+a_4 \log y+\varepsilon. \qquad [4]$$

Here variables denote

p=cost per case
d=physician-population ratio
n=number of cases per population
b=ratio of patient payment to total costs
y=mean income of the population.

III Characteristics of the Data

The data were collected from the pooled data on National Health Insurance scheme, of which population covers about 55 per cent of the total population. Since 55 per cent seems to be unable to show the whole phenomenon of the Japanese health care, it is necessary to explain the characteristics of the Japanese compulsory health insurance system.

All of the residents in Japan are covered by either one of severeal different health insurance schemes. However the difference exists only in the demand side of the health care. All patients, regardless with what they belong to any scheme, can freely choose the

1) See the technical appendix in Reinhardt [1978].
2) Reimbursement system does not clearly devide the physician's fee and the hospital charge. For instance, the clinic and the hospital buy medicines directly. Though prescription fees for the medicines are set quite lower, the clinic and the hospital can earn profits by providing drugs to the patients. Profit margins for the drugs are about 20 to 50 per cent of the purchasing cost. Instead, fees for the surgical operations are set at the lower level than those in the United States.

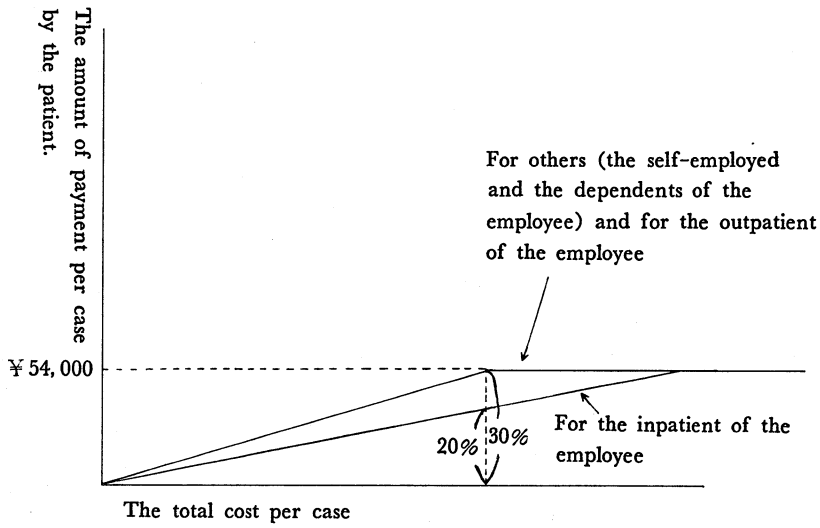

Fig. 1 Copayment Schedules under Different Health Insurance Schemes in Japan

clinic and the hospital. Only difference is the amount of insurance premium and the amount of the deductibles for the insurance. If we broadly classify several insurance schemes in two categories, those are one for the self-employed people and the other for the employed people and their family dependents.

Since the copayment schedules for these two categories, which is shown in Fig. 1, are not significantly different, recent number of the patient per population is quite similar in each insurance scheme for each age group. Age distribution of the component of the population among different insurance schemes, however, is different. Therefore, quantitative results should not be interpreted as having macroeconomic implication.

Though, however, it is not shown here, the same estimations in this paper for other insurance schemes were done. And the results are quite similar with the results shown in this paper.

Pooling was done in a way to pool 47 prefectural data with annual data from 1974 to 1983. Estimations were done for (1) five years from 1974 to 1978, (2) five years from 1979 to 1983, and (3) ten years from 1974 to 1983.

The reason why I devided the data into two periods is because there may be a significant structural change in the pattern of the demand for medical care. In order to know the structural change, it might be better to apply the Chow's test. However, here I estimated the data divided into two periods, because I wanted to characterize the difference of the coefficients.

White Papers on the Japanese Economy [1985] by Economic Planning Agency has tried to inquire the causes of the recent rising health care costs. In the study, it used the longer time series data for the econometric study on the determination of health care costs. It, however, did not check whether there is the structural change. Several studies

has shown that the main causes of the increasing health care costs in Japan has changed around the years 1979-80 from the increase of the number of patients to the technological progress in the health care fields.

As a matter of fact, the rate of the increase of the number of patients has significantly lowered since 1979. Therefore, we should be more careful in analyzing the relevant time data on the determination of health care costs.

The average population of 47 prefectures is about 2 million. Since recent studies on the regional variation of medical practices are done in smaller areas, aggregated data such as at the prefectural level are not comparable with those studies. Though I realize that more subdivided data should be relevant to these studies, I could not use such kinds of data. One main reason is that in more subdivided data there are so many spill overs of patients from one region to another region.

In my study, rate of the spill over from one prefecture to another prefecture is 18 per cent at the maximum value. Moreover, I obtained the almost same results with the following equations by excluding 4 or 5 prefectures where significant spill over occured.

IV Empirical Results

When we estimate the pooled time series data, it is often the case that there exist serial correlations in the disturbance term. Therefore, I will estimate the equation [4] in Table 1(a), (b), and (c). Here equation [4] is

$$\log p = a_0 + a_1 \log d + a_2 \log n + a_3 \log h + a_4 \log y + \varepsilon_{it}.$$

Secondly, letting

$$\varepsilon_{it} = \rho_i \varepsilon_{i,t-1} + u_{it}$$
$$E(\varepsilon_{it}^2) = \sigma^2,\ E(\varepsilon_{it}\varepsilon_{jt}) = 0,\ E(\varepsilon_{i-1,t}u_{jt}) = 0$$
$$u_{it} \sim N(0,\ \sigma_u^2),$$

ρ is estimated by OLS. And by using estimated value $\hat{\rho}$ of ρ I estimated following equation:

$$\log(p)^*_{it} = \log(p)_{it} - \hat{\rho} \log(p)_{i,t-1},$$
$$x^*_{kit} = x_{kxt} - \hat{\rho} x_{i,t-1},\ (k = 1,\ \ldots,\ 4)$$
$$u^*_{it} = \varepsilon_{it} - \hat{\rho}_i \varepsilon_{i,t-1}.$$

Therefore,

$$\log(p)^*_{it} = \alpha_0(1 - \hat{\rho}_i) + \sum_{k=1}^{4} \alpha_k x^*_{kit} + u^*_{it}$$

This is the same procedure shown in Pindyck and Rubinfeld [1981, 2nd edition. chap. 9.] These results are shown in Table 2 (a), (b), and (c).

Before interpreting the results, I want to explain the results of the preparatory estimations.

I tried to estimate the following potential candidates for the explanatory variables. (1) number of clinics and hospitals, (2) number of beds per population, (3) number of beds

Table 1(a) Estimation of the Health Care Costs per Case (1974-78) by OLS with Pooled Data

	const.	no. of physicians per population	no. of case per population	patient's costs/total costs	mean income/ population	$\bar{R}^2$ S.E. D.W.
Inpatient: (general and elderly people)	4.612	0.097 (1.824)	0.025 (0.539)	0.092 (0.729)	0.679 (9.547)	0.310 0.124 0.833
Outpatient: (general and elderly people)	0.580	0.136 (3.812)	0.242 (2.657)	−0.109 (1.204)	0.408 (8.861)	0.465 0.080 0.915
Inpatient: (excluding elderly people)	4.726	0.076 (1.646)	0.007 (0.145)	0.200 (1.955)	0.689 (9.544)	0.301 0.120 0.910
Outpatient: (excluding elderly people)	0.753	0.124 (3.543)	0.111 (1.139)	−0.109 (1.562)	0.503 (9.733)	0.463 0.082 0.872
Inpatient: (elderly people)	4.525	0.088 (1.865)	−0.099 (4.299)	—	0.808 (11.066)	0.444 0.127 0.927
Outpatient: (elderly people)	0.853	0.239 (7.504)	0.105 (1.243)	—	0.369 (6.938)	0.398 0.089 1.568

Footnote: t-values in parentheses.

in hospitals with more 300 beds, (4) population of densely populated area/population (5). The reason why variables (1), (2) and (4) are candidates might be clear. Since cost per case might be higher in large hospitals than those in smaller hospitals, I picked it up as a variable.[3)]

However, none of these variables increased the explanatory power of the results shown below. The physician-population ratio is the most dominant variable in explaining cost per case. Though variables (1) to (3) are positively correlated with the physician-population ratio, those are less powerful factors.

Althogh, in what follows, I will interpret the results shown in Table 2. I will indicate one comment for the interpretation of the Table (1). The reason why I showed Table 1 is that there is a doubt whether this estimation is suitable in taking account the serial correlation for only short period like 5 years. The results shown in Table 1 is quite similar with those in Table 2. Therefore, regardless of the way of estimation, following interpretations are robust in this sense.

3) See, for instance, Okinaka Research Institute [1980].

Table 1(b) Estimation of the Health Care Costs per Case (1979-83) by OLS with Pooled Data

	const.	no. of physicians per population	no. of case per population	patient's costs/total costs	mean income/ population	$\bar{R}^2$ S.E. D.W.
Inpatient: (general and elderly people)	3.482	0.132 (4.250)	−0.263 (10.865)	−0.342 (6.620)	0.206 (4.559)	0.545 0.069 1.473
Outpatient: (general and elderly people)	0.982	0.187 (5.928)	−0.151 (1.942)	−0.173 (5.597)	0.316 (8.404)	0.477 0.067 1.550
Inpatient: (excluding elderly people)	3.739	0.135 (5.012)	−0.198 (7.598)	−0.230 (5.329)	0.180 (4.331)	0.446 0.065 1.425
Outpatient: (excluding elderly people)	0.956	0.097 (3.719)	−0.016 (0.214)	−0.318 (7.963)	0.246 (6.762)	0.502 0.060 1.332
Inpatient: (elderly people)	4.469	0.134 (3.684)	−0.219 (10.508)	—	0.506 (9.488)	0.567 0.091 1.676
Outpatient: (elderly people)	1.675	0.288 (8.063)	−0.328 (2.940)	—	0.413 (7.419)	0.334 0.097 1.549

Footnote: t-values in parentheses.

A priori sign conditions are almost satisfied in Table 2, except that some coefficients on the ratio of the copayment. This might be because regional variation of the ratio of the copayment is not so significant at all.

At first, the null hypothesis that physician-population ratio is zero is rejected at 1 per cent level at any estimation. This indicates that the competitive market hypothesis is not accepted.

We can raise several side-evidences on the plausibility of the physician-induced demand hypothesis in Japan. Here I show some of them. Most of patients do not try to get information on the health care at the clinic or at the hospital. A study by some consumer activists shows that more than 70 per cent of the patient who visited the hospital did not ask the name of drugs prescribed at the clinic or the hospital.

Recently, some of European countiries and the United States are trying to make technology assessments on health care in order to inform people of the way choose to alternative health cares. However, in Japan, these assessements are not being done. The reason why the necessity of these assessements are not recognized in Japan is that patients are more dependent on physicians, that is patient-physician relationship is quite

Table 1(c) Estimation of the Health Care Costs per Case (1974-83) by OLS with Pooled Data

	const.	no. of physicians per population	no. of case per population	patient's costs/total costs	mean income/ population	$\bar{R}^2$ S.E. D.W.
Inpatient: (general and elderly people)	4.641	0.072 (1.845)	0.076 (2.731)	−0.056 (0.729)	0.863 (18.848)	0.526 0.128 1.103
Outpatient: (general and elderly people)	0.403	0.133 (4.783)	0.366 (5.827)	−0.133 (3.648)	0.501 (15.515)	0.642 0.086 0.973
Inpatient: (excluding elderly people)	4.881	0.090 (2.646)	0.103 (3.366)	0.177 (2.955)	0.809 (18.840)	0.509 0.121 1.147
Outpatient: (excluding elderly people)	0.623	0.130 (4.913)	0.275 (3.874)	−0.030 (0.714)	0.588 (17.709)	0.607 0.087 0.941
Inpatient: (elderly people)	4.515	0.109 (2.953)	−0.054 (3.052)	—	1.034 (22.088)	0.552 0.137 1.186
Outpatient: (elderly people)	0.931	0.267 (10.981)	0.020 (0.309)	—	0.433 (11.561)	0.481 0.095 1.513

Footnote: t-values in parentheses.

different in Japan.

This patient dependency on physician will also support the physician-induced demand hypothesis in Japan.

At the same time, many physicians who have ever practised in the United States, witness that Japanese patients more highly rely than those in the United States on the diagnosis and the treatment without questioning the implication of them.

Regional variation of the cost per case is persistent at least during past two decades. Though the mobility of patients between different areas are gradually smoothing, high correlation between cost per case and the physician-population ratio has not changed.

Secondly, I would like to investigate the relationship between the number of case per population (n) and the cost per case (p). If n and p are positively correlated, this implies that decreased number of patients will not raise the total cost of health care ($p\ n$). In other words, in this case, policies to reduce the number of patients may be effective in reducing the cost of health care.

However, the results show that, except for the case of the elderly patients, these policies will not effective. Since results shown in Table 2 are expressed in logarithmistic

Table 2(a) Estimation of the Health Care Costs per Case (1974-78) by Considering the Serial Correlation

	$\hat{\rho}$	no. of physicians per population	no. of case per population	patient's costs/total costs	mean income/ population	$\bar{R}^2$ S.E. D.W.
Inpatient:	4.627	0.084	−0.010	0.091	0.656	0.999
(general and elderly people)	(18.424)	(1.878)	(0.276)	(1.088)	(18.424)	0.040
Outpatient:	0.644	0.207	−0.015	−0.115	0.378	0.996
(general and elderly people)	(3.717)	(5.265)	(0.188)	(1.409)	(7.781)	0.030
Inpatient:	4.548	0.076	−0.042	0.122	0.657	0.999
(excluding elderly people)	(20.176)	(2.009)	(1.186)	(1.771)	(10.846)	0.040
Outpatient:	0.698	0.204	−0.168	−0.183	0.501	0.995
(excluding elderly people)	(−0.669)	(5.291)	(2.152)	(2.704)	(9.165)	0.032
Inpatient:	4.805	0.032	−0.090	—	0.842	0.999
(elderly people)	(20.521)	(0.671)	(4.589)		(13.111)	0.042
Outpatient:	0.887	0.236	0.097	—	0.228	0.999
(elderly people)	(7.763)	(7.933)	(1.518)		(6.917)	0.027

Footnote: t-values in parentheses.

Table 2(b) Estimation of the Health Care Cost per Case (1979-83) by Considering the Serial Correlation

	$\hat{\rho}$	no. of physicians per population	no. of case per population	patient's costs/total costs	mean income/ population	$\bar{R}^2$ S.E. D.W.
Inpatient:	3.621	0.165	−0.269	−0.173	0.154	0.999
(general and elderly people)	(27.103)	(7.253)	(13.826)	(6.427)	(4.866)	0.031
Outpatient:	1.079	0.159	−0.071	−0.122	0.267	0.999
(general and elderly people)	(12.213)	(7.141)	(1.543)	(7.314)	(8.856)	0.035
Inpatient:	3.636	0.165	−0.257	−0.120	0.120	0.999
(excluding elderly people)	(23.218)	(6.831)	(9.843)	(4.995)	(3.918)	0.032
Outpatient:	1.172	0.056	0.053	−0.217	0.232	0.999
(excluding elderly people)	(15.211)	(2.968)	(1.066)	(8.168)	(6.928)	0.034
Inpatient:	4.773	0.075	−0.214	—	0.446	0.999
(elderly people)	(24.354)	(1.925)	(10.776)		(13.109)	0.034
Outpatient:	2.064	0.368	−0.651	—	0.341	0.998
(elderly people)	(10.381)	(11.274)	(7.719)		(6.699)	0.039

Footnote: t-values in parentheses.

Table 2(c) Estimation of the Health Care Costs per Case (1974-83) by Considering the Serial Correlation

	$\hat{\rho}$	no. of physicians per population	no. of case per population	patient's costs/total costs	mean income/ population	$\bar{R}^2$ S.E. D.W.
Inpatient:	4.294	0.194	0.087	0.061	0.611	0.994
(general and elderly people)	(21.722)	(5.032)	(3.540)	(6.639)	(16.941)	0.036
Outpatient:	0.522	0.211	0.114	−0.077	0.436	0.994
(general and elderly people)	(4.198)	(6.699)	(1.926)	(−4.772)	(13.172)	0.035
Inpatient:	4.507	0.101	0.001	0.063	0.593	0.999
(excluding elderly people)	(22.207)	(2.831)	(0.174)	(1.979)	(16.306)	0.039
Outpatient:	0.675	0.195	0.011	−0.053	0.504	0.990
(excluding elderly people)	(5.214)	(6.577)	(0.171)	(−1.836)	(14.518)	0.036
Inpatient:	4.556	0.101	−0.092	—	0.716	0.998
(elderly people)	(21.437)	(2.316)	(−4.855)		(15.877)	0.042
Outpatient:	1.134	0.328	−0.188	—	0.291	0.997
(elderly people)	(10.144)	(13.659)	(−3.531)		(9.416)	0.036

Footnote: t-values in parentheses.

term, coefficient on the number of case per population implies the fee elastisity of the demand. The value of this coefficient ranges from −0.269 to 0.053. −0.269 means that one per cent decrease of the number of cases rusults 0.269 per cent increase of the cost per case. In this sense, policies to reduce the number of patient visit has compensated by the clinic or the hospital to some extent.

V Concluding Remarks

Researches on the determination on the cost of health care in Japan in still less developed than in other developed countries. It is mainly due to the limits of data availability. Moreover, although this stuty done in this paper is interesting as the epidemiological studies, those are also far less developed.

Anecdotally, physicians realize that significant regional variations are due to the physician-induced demand nature of their practices. Though government officials are suggesting that regional variations are not favorable from the view point of equity among regions, physicians are objecting to this viewpoint. Because medical practice has results in the different costs by its nature.

In this paper, I have shown that regional variations have been persistent during at least ten years. This means, on one hand, professional uncertainty is not the main cause of the regional variations.[4] On the other hand, it means that physicians do not move

4) The term 'professional uncertainty' should be referred to Wennburg [1983].

to more profitable areas from more dispersed area. Though I believe that I could show that physician-induced demand hypothesis is pursuasive in Japan, mystery of the regional variation is not still resolved.

There are so many thing to be done by the collaboration with epidemiologists and economists. I hope this paper to be just a first step to this collaboration.

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